The United States Detailed National Report on Systematic Observations for Climate:

United States Global Climate Observing System (U.S.-GCOS) Program

Submitted to the Conference of the Parties to the United Nations Framework Convention on Climate Change

Compiled by the National Oceanic and Atmospheric Administration on Behalf of the United States Government

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Compiled on Behalf of the United States Government by the:

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service
1335 East-West Highway, Room 7214
Silver Spring, Maryland, USA 20910
Howard Diamond, U.S. GCOS Program Coordinator

http://www.eis.noaa.gov/gcos
e-mail contact: howard.diamond@noaa.gov

Department of Commerce
Donald L. Evans, Secretary

National Oceanic and Atmospheric Administration
Scott B. Gudes, Acting Under Secretary / Administrator and Deputy Under Secretary

National Environmental Satellite, Data, and Information Service
Gregory W. Withee, Assistant Administrator

Preface

Long-term, high-quality observations of the global environmental system are essential for defining the current state of the Earth's system, and its past history and variability. This task requires both space- and surface-based observation systems. The term "climate observations" can encompass a broad range of environmental observations. These include:

(1) Routine weather observations, which, collected over a long enough period, can be used to help describe the climatology of a region.
(2) Observations collected as part of research investigations to elucidate chemical, dynamical, biological, or radiative processes that contribute to maintaining climate patterns or to their variability.
(3) Highly precise, continuous observations of climate system variables collected for the express purpose of documenting long-term (decadal to centennial) change.
(4) Observations of climate proxies, collected to extend the instrumental climate record to remote regions and back in time to provide information on climate change for millennial and longer time scales.

Because this is the first government attempt to document all U.S. contributions to global climate observations, a wide net was cast to include information on observations that fall into each of these categories.

The sections of the report delineate climate monitoring from five distinct yet integrated areas: (1) *in-situ* atmospheric observations; (2) *in-situ* oceanographic observations; (3) *in-situ* terrestrial observations; (4) satellite based observations which by their nature cut across the atmospheric, oceanographic, and terrestrial domains; and (5) data and information management related to systematic observations**.**

The various federal agencies involved in climate observing, through space-based and ground-based activities, provide many of the required long-term observations. Space-based systems have the unique advantage of obtaining global spatial coverage, particularly over the vast expanses of the oceans, sparsely populated land areas (e.g., deserts, mountains, forests, and polar regions), and the mid and upper troposphere and stratosphere. They provide unique measurements of solar output, the Earth's radiation budget, vegetation cover, ocean biomass productivity, atmospheric ozone, stratospheric water vapor and aerosols, greenhouse gas distributions, sea level and ocean interior, ocean surface conditions and winds, weather, and tropical precipitation, among others.

Satellite observations alone are not sufficient; they require *in-situ* measurements for calibration and validation. *In-situ* observations are required for the measurement of parameters that cannot be estimated from space platforms (e.g., biodiversity, groundwater, carbon sequestration at the root zone, and subsurface ocean parameters). They also provide long time series of observations required for the detection and diagnosis of global change, such as surface temperature, precipitation and water resources, weather and other natural hazards, the emission or discharge of pollutants, and the impacts of multiple stresses on the environment due to human and natural causes. To meet the need for the documentation of global changes on a long-term basis, the U.S. integrates observations from both research and operational systems. The goal of the U.S.'s observation and monitoring program is to ensure a long-term, high-quality record of the state of

the Earth system, its natural variability, and changes that occur. The U.S. will continue to support systematic observations in support of climate monitoring, and will provide reports of this nature in the future.

Gregory W. Withee, Member of the International GCOS Steering Committee
Assistant Administrator for Satellite and Data Information Services
National Environmental Satellite, Data, and Information Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Silver Spring, Maryland
August 2001

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Material for this report was developed by a U.S. interagency Global Climate Observing System (GCOS) coordination group comprised of representatives from the following federal agencies: (1) the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) and U.S. Forest Service (USFS); (2) three line offices of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA); (3) the U.S. Department of Energy's (DOE) Office of Science; (4) the U.S. Environmental Protection Agency (EPA); (5) the U.S. Department of the Interior's U.S. Geological Survey (USGS); (6) the National Aeronautics and Space Administration (NASA); (7) the U.S. Department of Transportation's Federal Aviation Administration; (8) the National Science Foundation (NSF); (9) the U.S. Naval Oceanographic Office; (10) the U.S. Army Corps of Engineers (USCOE); and (11) the U.S. Air Force. The report was coordinated with the U.S. Global Change Research Program.

This report was prepared as directed by United Nations Framework Convention on Climate Change (UNFCCC) Decision CP/1999/L.3, which requested all Annex I Parties to provide a detailed report on systematic observations in accordance with the UNFCCC reporting guidelines on global climate change observing systems adopted by UNFCCC Decision CP/1999/L.4. The principles of this report are based on climate observing requirements for observing networks, practices, and data management as agreed to internationally in "The Plan for the Global Climate Observing System (GCOS)," Version 1.0, May 1995 GCOS-14 (WMO/TD-No. 681).

NOAA wishes to express its great appreciation to the large group of individuals from many federal agencies for coming together and producing this very detailed and informative report characterizing the vital and diverse aspects of the U.S.'s global climate observing effort.

Contributors to the Report

Overall Report Coordinator: Howard Diamond, U.S. GCOS Program Manager

Atmospheric Section Coordinator: Russell Vose, NOAA/National Climatic Data Center

Contributors:

Richard Artz, NOAA/ARL
John Augustine, NOAA/ETL
Carl Bower, NOAA/NWS
John Deluisi, NOAA/ARL
Rainer Dombrowsky, NOAA/NWS
Bruce Hicks, NOAA/ARL
Detlef Matt, NOAA/ARL
Thomas Peterson, NOAA/NCDC
Rick Petty, DOE Office of Science
Marc Pitchford, NOAA/ETL
Steven Pritchett, NOAA/NWS
Russell Schnell, NOAA/CMDL
Dian Seidel, NOAA/ARL
Bob Thomas, NOAA/NWS
Ed Young, NOAA/NWS

Oceanographic Section Coordinator: Steve Piotrowicz, NOAA Research

Contributors:
John Calder, NOAA/OAR
Muriel Cole, NOAA Office of the Chief Scientist
Elizabeth Horton, Naval Oceanographic Office
Michael Johnson, NOAA/OGP
Paul Moersdorf, NOAA/NWS/NDBC
Rik Wanninkhof, NOAA/AOML
Stan Wilson, NOAA Office of the Chief Scientist

Terrestrial Section Coordinator: David Clark, NOAA/National Geophysical Data Center

Contributors:
Roger Barry, NSIDC
Jerry Brown, IPA
Tom Carroll, NOAA/NWS
Gary Clow, USGS
Mark Eakin, NOAA/NGDC
Florence Fetterer, NSIDC
Michael Jasinski, NASA
Gregory Johnson, USDA/NRCS
John Lyon, EPA
Lawrence Pettinger, USGS
Rick Petty, DOE Office of Science
Al Riebau, USFS
Kernell Ries, USGS
Hal Walker, EPA
David Wingerd, USCOE
Ed Young, NOAA/NWS

Satellite Remote Sensing Section Coordinator: Robert Schiffer, NASA

Contributors:
John Faundeen, USGS/EROS Data Center
Arnold Gruber, NOAA/NESDIS
Herbert Jacobowitz, NOAA/NESDIS
Steve Mango, NOAA/NESDIS
George Ohring, NOAA/NESDIS
Lawrence Pettinger, USGS
Tim Smith, USGS/EROS Data Center
Sushel Unninayar, NASA
Tim Walsh, NOAA/NESDIS

Other Contributors:
Donald Carver, NOAA/OFCM
Billie Cooper, NOAA/NWS
David Goodrich, NOAA/OAR
Reid Harvey, EPA
Linda Moodie, NOAA/NESDIS
Thomas Spence, National Science Foundation
Colonel H.W. Tileston, U.S. Air Force
Robert C. Worrest, U.S. Global Change Research Information Office

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Executive Summary

Since 1998, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have noted with concern the mounting evidence of a decline in the global observing capability and have urged Parties to undertake programs of systematic observations and to strengthen their capability in the collection, exchange, and utilization of environmental data and information. It has long been recognized that the range of global observations needed to understand and monitor Earth processes contributing to climate and to assess the impact of human activities cannot be satisfied by a single program, agency, or country. The U.S. supports the need to improve global observing systems for climate, and we join other Parties in submitting information on national plans and programs that contribute to the global capability. This report was prepared as directed by UNFCCC Decision CP/1999/L.3, which requested Annex I Parties to provide a detailed report on systematic observations in accordance with the UNFCCC reporting guidelines on global climate change observing systems adopted by the UNFCCC Decision CP/1999/L.4.

The U.S. actively supports the Global Climate Observing System (GCOS) through its participation in and support of the GCOS networks, and through its support of related climate observing activities. The U.S. recognizes that international cooperation both in data collection and sharing of information is essential to provide the climate information required by the UNFCCC.

With regard to capacity building, the initial climate report of the George W. Bush Administration noted that national and international bodies have "identified the building of a global observing system to monitor climate as being crucial to improving our understanding of the science of climate change. This system must include developing countries that have limited resources to make the necessary measurements." It further states that the U.S. will "provide resources to help build climate observation systems in developing countries throughout the world, and call upon other developed countries to provide matching funds for such an investment."

This report delineates climate monitoring in the U.S. in five distinct yet integrated areas: (1) *in-situ* atmospheric observations; (2) *in-situ* oceanographic observations; (3) *in-situ* terrestrial observations; (4) satellite based observations which by their nature cut across the atmospheric, oceanographic and terrestrial domains; and (5) data and information management related to systematic observations. The report attempts to include observation systems now known to be relevant, but is representative of the larger U.S. effort to observe environmental variables.

The U.S. actively participates in the GCOS Surface Network (GSN), the GCOS Upper Air Network (GUAN), and the Global Atmospheric Watch (GAW). The US supports 75 GSN stations, 20 GUAN stations, and 4 GAW stations. These stations are distributed geographically as prescribed in the GCOS and GAW network designs. The data (metadata and observations) from these stations are shared according to GCOS and GAW protocols. The GSN and GUAN stations are part of a larger network, which was developed for purposes other than climate monitoring. Nonetheless, the stations fully meet the GCOS requirements. In general, the National Oceanic and Atmospheric Administration (NOAA) operates most of the U.S. GCOS atmosphere-related networks.

There is no comprehensive system designed to observe climate change and climate variability in the U.S. Basically, sustained observing systems in the U.S., which provide continuing observations, provide data principally for non-climatic purposes, such as predicting weather, advising the public, and managing resources. In addition, there are research-observing systems that collect data for climate purposes, but they are often oriented toward gathering data for climate process studies or other research programs rather than climate monitoring. They are usually limited in their spatial and temporal extent. Because the U.S. climate record is based upon a combination of existing operational and research programs, it may not be "ideal" from a long-term climate monitoring perspective. Nevertheless, these observing systems collectively provide voluminous and significant information about the spatial and temporal variability of climate in the U.S. and contribute to the international climate observing effort as well. The detailed atmospheric section in the main body of the report examines *in-situ* climate monitoring involving systems from the surface, upper air, and atmospheric deposition domains.

Table 1. U.S. Participation in the Global Atmospheric Observing Systems

	GSN	GUAN	GAW	OTHER
How many stations are the responsibilities of the Party?	75	20	4	See Section I
How many of those are operating now?	75	20	4	See Section I
How many of those are operating to GCOS standards now?	75	20	4	See Section I
How many are expected to be operating in 2005?	75	21	4	See Section I
How many are providing data to international data centres now?	75	20	4	See Section I

The GCOS requirements for ocean observations are the same as the climate requirements for the Global Ocean Observing System (GOOS). Both are based on the Ocean Observing System Development Panel (OOSDP) Report, (OOSDP, 1995), which can be found at http://www-ocean.tamu.edu/OOSDP/FinalRept/t_of_c.html. The GOOS, like GCOS, is based on a number of *in-situ* and space-based observing components. The US contributes to all of these components. It supports surface and marine observations through 149 fixed buoys, over 500 surface drifting buoys, nearly 200 sub-surface floats, and over 1500 volunteer observing ships as part of the Integrated Global Ocean Observing System (IGOSS). It provides support for 244 sea-level tide gauges through the Global Sea Level Observing System (GLOSS). It currently provides satellite coverage of the global oceans for sea surface temperatures, surface elevation, ocean surface winds, sea ice, ocean color, and other variables of climate relevance. These satellite activities are coordinated internationally through the Committee on Earth Observation Satellites (CEOS).

Table 2. U.S. Participation in the Global Oceanographic Observing Systems[1]

	VOS	SOOP	Tide Gauges	Surface Drifters	Sub-Surface Floats	Moored Buoys	ASAP
For how many platforms is the Party responsible?	1557	51	244	~540/year	187	149*	<1
How many are providing data to international data centres?	1470	51	244	~800 (1½- 2 year lifetime)	187	149*	<1
How many are expected to be operating in 2005?	1470	51	244	~800	~1,000	~130*	<1

* Includes 5 mooring pairs along the equator in the Pacific, research moorings in the Arctic and Pacific, two time series sites, and an international collaborative program in the Atlantic.

- ASAP – Automated Shipboard Aerological Program
- SOOP – Ships of Opportunity
- VOS – Voluntary Observing Ships

Note: For Table 2, contributing to an international data centre is considered to be data available on the Global Telecommunications System (GTS) that is available to be downloaded from an ftp or other site either directly or via the Distributed Oceanographic Data System (DODS), as well as to world data centres.

For terrestrial observations, the requirements for climate observations were developed jointly between GCOS and the Global Terrestrial Observing System (GTOS) through the Terrestrial Observations Panel for Climate (TOPC); see GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 2.0 June 1997, GCOS-32 (WMO/TD-No. 796). GCOS and GTOS, have identified permafrost thermal state and permafrost active layer as key variables for monitoring the state of the cyrosphere. GCOS approved the development of a globally comprehensive permafrost monitoring network to detect temporal changes in the solid earth component of the cryosphere. As such, the Global Terrestrial Network for Permafrost (GTN-P) is quite new and still very much in the developmental stage. The International Permafrost Association (IPA) has the responsibility for managing and implementing the GTN-P.

In the U.S., contributions to the GTN-P network are provided by the Department of the Interior and the NSF, through grants to various universities. All the U.S. GTN-P stations are located in Alaska. The active layer thickness is currently being monitored at 27 sites. Forty-eight boreholes exist in Alaska where permafrost thermal state can be determined. Of these, 4 are classified as *Surface* (0-10 m) sites, 1 is *Shallow* (10-25 m), 22 are *Intermediate Depth* (25-125 m), and 21 are *Deep Boreholes* (>125 m). U.S. contribution to the GTN-P network comes from short-term (3-5 year) research projects.

The U.S. operates a long-term "benchmark" glacier program to intensively monitor climate, glacier motion, glacier mass balance, glacier geometry, and stream runoff at a few select sites. The data collected are used to understand glacier-related hydrologic processes and improve the quantitative prediction of water resources, glacier-related hazards, and the consequences of climate change.

1 See also http://ioc.unesco.org/goos/act_pl.htm for details of ocean observation requirements.

The approach has been to establish long-term mass balance monitoring programs at three widely spaced glacier basins in the U.S. that clearly sample different climate-glacier-runoff regimes. The three glacier basins are South Cascade Glacier in Washington State, and Gulkana and Wolverine Glaciers in Alaska. Mass balance data are available beginning in 1959 for the South Cascade Glacier, and beginning in 1966 for the Gulkana and Wolverine Glaciers.

The AmeriFLUX network endeavors to establish an infrastructure for guiding, collecting, synthesizing, and disseminating long-term measurements of CO_2, water, and energy exchange from a variety of ecosystems. Its objectives are to collect critical new information to help define the current global CO_2 budget, enable improved predictions of future concentrations of atmospheric CO_2, and enhance the understanding of carbon fluxes, Net Ecosystem Production (NEP), and carbon sequestration in the terrestrial biosphere.

The terrestrial section of the report examines *in-situ* climate monitoring and involves, in addition to the GTN-P, GTN-G, and AmeriFLUX programs, streamflow and surface water gaging, ground water monitoring, snow and soil monitoring, the U.S. paleoclimatology program, ecological observation networks, fire weather observation stations, as well as global, national, and regional land cover characterization. The U.S. contributes to all of these components, and supports 77 GTN-P sites, 3 GTN-G sites, and 52 Fluxnet sites.

Table 3. U.S. Participation in the Global Terrestrial Observing Systems

	GTN-P	GTN-G	FLUXNET AmeriFlux	Other
How many sites are the responsibilities of the Party?	77	3	52	See Section III
How many of those are operating now?	77	3	47	See Section III
How many are providing data to international data centres now?	77	3	24	See Section III
How many are expected to be operating in 2005?	80	0	50	See Section III

Space-based, remote sensing observations of the atmosphere-ocean-land system have evolved substantially since the early 1970's when the first operational weather satellite systems were launched. Over the last decade satellites have proven their observational capabilities to accurately monitor nearly all aspects of the total Earth system on a global basis; a capability unmatched by ground-based systems that are limited to land areas and cover only about 30% of the planetary surface. Currently, satellite systems monitor the evolution and impact of the El-Nino, weather phenomena, natural hazards, and extreme events such as floods and droughts, vegetation cycles, the ozone hole, solar fluctuations, changes in snow cover, sea ice and ice sheets, ocean surface temperatures and biological activity, coastal zones and algae blooms, deforestation, forest fires, urban development, volcanic activity, tectonic plate motions, and others. These various observations are used extensively in real-time decision-making and the strategic planning and management of industrial, economic, and natural resources. Examples include weather and climate forecasting, agriculture, transportation, energy and water resources management, urban planning, forestry, fisheries, and early warning systems for natural disasters and human health impacts.

Table 4. U.S. Environmental Satellite Program

	Polar Orbiting (Operational)	Geostationary (Operational)	Research (Systematic and Experimental Observations)
For how many platforms is the Party responsible?	2 – Landsat 2 – POES 2 – DMSP	2 – GOES	21 (See Section IV)
How many of those are operating now?	2 – Landsat 2 – POES 2 – DMSP	2 – GOES	21 (See Section IV)
How many are providing data to international data centres?	2 – Landsat 2 – POES 2- DMSP	2 - GOES	10 (See Section IV)
How many are expected to be operating in 2005?	1 – Landsat 1 – POES 2 – DMSP	2 - GOES	14 (See Section IV)

The GCOS planning process addressed satellite requirements for climate. In so doing, GCOS identified an extensive suite of variables that should be observed and monitored from space; see GCOS Plan for Space-based Observations, GCOS-14 (WMO/TD – No. 681). In addition, GCOS plans specified that instrument calibration and validation be performed to ensure that the resulting space-based observations meet climate requirements for accuracy, continuity, and low bias.

The current generation of U.S. research satellite instruments exceeds the GCOS requirements for the absolute calibration of sensors, something that was lacking in the early satellite platforms used for real-time operational purposes. Regarding historical satellite data, several of the data series from operational satellites have been re-processed using substantially improved retrieval algorithms and, therefore, provide good quality global data products for the purposes of GCOS and climate system variability and climate change research and applications. Improving the on-board capabilities for calibration on operational satellites will be one of the objectives considered in the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program. Prior to the launch of NPOESS in 2008, an NPOESS Preparatory Project (NPP) satellite will be launched in the 2005 timeframe as a bridge mission between the NASA Earth Observing Satellites (EOS) program and NPOESS. The mission of NPP is to demonstrate advanced technology for atmospheric sounding, providing ongoing observations about global change after EOS-Terra and EOS Aqua. It will supply data on atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, and cloud and aerosol properties. NPP will contribute to instrument risk reduction by offering early instrument and system level testing, lessons learned for design modifications in time to ensure NPOESS launch readiness, ground system risk reduction, early user evaluation of NPOESS data products, such as algorithms, and instrument verification, and opportunities for instrument calibration.

The satellite observations section of this report details a number of U.S. satellite operational and research missions in support of climate monitoring. The instruments on the Geostationary Operational Environmental Satellites (GOES) and Polar Operational Environmental Satellites (POES), the series of Earth Observing Satellites (EOS), the Landsats 5 and 7, as well as the Total Ozone Mapping Spectrometer satellite and TOPEX/Poseidon satellite measuring sea surface

height, winds, and waves form the basis of a robust national remote sensing program that fully supports the requirements of GCOS. Additional satellite missions in support of GCOS and described in the satellite observations section include: (1) the Active Cavity Radiometer Irradiance Monitor (ACRIM) for measuring solar irradiance; (2) EOS-Terra; (3) QuickSCAT; (4) the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) for studying ocean productivity; (5) the Shuttle Radar Topography Mission (SRTM); (6) the Tropical Rainfall Measuring Mission (TRMM) for measuring rainfall, clouds, sea surface temperature, radiation, and lightning; and (7) QuickSCAT. In addition, a number of missions still to be launched are included in this group of environmental satellites.

The Defense Meteorological Satellite Program (DMSP) is a Department of Defense (DOD) program run by the Air Force Space and Missile Systems Center (SMC). The DMSP program designs, builds, launches, and maintains several near-polar orbiting, sun synchronous satellites, monitoring the meteorological, oceanographic, and solar-terrestrial physics environments. DMSP satellites are in a near-polar, sun synchronous orbit at an altitude of approximately 830 kilometers (km) above the earth. Each satellite crosses any point on the earth up to two times a day and has an orbital period of about 101 minutes, thus providing nearly complete global coverage of clouds every six hours.

The U.S. cooperates on an international basis with a number of coordinating bodies, including the Integrated Global Observing Strategy (IGOS). IGOS is a strategic planning process, uniting the major satellite and surface-based systems for global environmental observations of the atmosphere, oceans and land, in a framework for decisions and resource allocations by individual funding agencies. Its purview includes observations for climate, and the needs of multiple domains—the entirety of which no single Partner is able to address alone. It takes a strategic view across all Earth observing requirements, evaluates capabilities of current and planned observing systems, and has begun (at least among the space agencies) to obtain commitments for addressing the gaps. An IGOS Ocean Theme is in the implementation phase under leadership from GOOS. An analysis of requirements, gaps, and recommendations for priority observations is underway for integrated global carbon observations as well as integrated global atmospheric chemistry observations. Prospectively, similar analyses, recommendations, and commitments will likely be undertaken in the areas of the water cycle, geo-hazards, and coral reefs.

Operational weather satellites are internationally coordinated through the Coordination Group for Meteorological Satellites (CGMS), of which the World Meteorological Organization is a member and major beneficiary. CGMS has six satellite agency members. The primary body for policy and technical issues of common interest related to the whole spectrum of Earth observation satellite missions is the CEOS. CEOS has 22 space agency members, including both research and operational satellite agencies, with funding and program responsibilities for a satellite Earth observation program currently operating or in the later stages of system development. CEOS encourages compatibility among space-borne Earth observing systems through coordination in mission planning, promotion of full and non-discriminatory data access, setting of data product standards, and development of data products, services, applications, and policies.

Global environmental concerns are an overriding justification for the unrestricted international exchange of GCOS data and products for peaceful, non-commercial, global scientific and applications purposes. As such, GCOS developed an overarching data policy that endorses the full and open sharing and exchange of GCOS-relevant data and products for all GCOS users as a

fundamental objective; these data and products should be provided at the lowest possible cost to GCOS users. The U.S. recognizes this and subscribes to GCOS' data policy.

Achieving the goals of the U.S. climate-observing program requires multidisciplinary analysis of data and information to an extent never before attempted. This includes the analysis of interlinked environmental changes that occur on multiple temporal and spatial scales, which is very challenging both technically and intellectually. For example, many types of satellite and *in-situ* observations at multiple scales need to be integrated with models and the results presented in understandable ways to all levels of the research community, decision makers, and the public. Additionally, very large volumes of data from a wide variety of sources and results from many different investigations need to be readily accessible to scientists and other stakeholders in usable forms that can be integrated.

Various U.S. agencies have engaged in extensive development of interagency data and information processes to address these needs, primarily through fostering better integration among U.S. Government data and discipline specific information. The Global Change Data and Information System (GCDIS) has been developed in response to this need and to facilitate data accessibility. GCDIS currently provides a gateway for discovery and information access among more than 70 federally funded sources of data, both governmental and academic. During the last decade, significant strides have been made in GCDIS' seamless connections between diverse data sets and sources, as well as its ability to search across the full complement of sources. The World Wide Web has facilitated this effort, however, important challenges remain.

The provision of data and information in forms needed for cross-disciplinary analyses and projections remain a challenge, even as the increasing focus of the U.S. agencies on investigating the impacts and consequences of change heightens the need for multidisciplinary research. Physical and biological data needs to be related to data on environmental conditions and socioeconomic trends originally compiled for other purposes. This is a particularly important challenge in addressing potential regional consequences of multiple stresses and determining the vulnerability of different resources and communities.

While a wide net has been cast to include information on each of the observing categories of this report, it is the position of the U.S. government (as evidenced by its active support of the 10 Principles of Climate Observations, and of the U.S. climate research community [National Research Council, 1999]), that high standards must be met if a particular set of observations is to serve the purpose of monitoring the climate system to detect long-term change. In general, the observing programs and resulting datasets described herein do not meet the ten "Climate Monitoring Principles" endorsed by the U.S. and UNFCCC. This shortfall stems from two main factors: 1) the principles were articulated only within the past decade (Karl et al. 1995), long after the initiation of most of our long-term observing systems; and 2) more recent observing programs typically do not have climate monitoring as their prime function.

It is hoped that the detailed information contained in this report will aid the GCOS Secretariat in the analysis of the state of global climate observing, as charged by the UNFCCC. The inclusion of this level of detail and the format of the supplementary tables for each section was developed, in concert with the GCOS Secretariat, at an informal meeting of GCOS national coordinators in Melbourne, Australia, in August 2000. This additional detail, while voluntary on the part of nations, should assist the secretariat in this endeavor. There are a number of overarching science

questions dealing with how the Earth-Climate System is changing and what the consequences are for life on Earth. These questions are as follows:

- ***How is the global Earth-Climate system changing? (Variability-V)***
  - How are global precipitation, evaporation, and the cycling of water changing?
  - How is the global ocean circulation varying on interannual, decadal, and longer time scales?
  - How are global ecosystems changing?
  - How is stratospheric ozone changing as the abundance of ozone-destroying chemicals decreases and new substitutes increases?
  - What changes are occurring in the mass of the Earth's ice cover?

- ***What are the primary forcings of the Earth-Climate system? (Forcing-F)***
  - What trends in atmospheric constituents (including aerosols) and solar radiation are driving global climate?
  - What changes are occurring in global land cover and land use, and what are their causes?
  - How is the Earth's surface being transformed and how can such information be used to predict future climate changes?

- ***How does the Earth-Climate system respond to natural and human-induced changes? (Response-R)***
  - What are the effects of clouds and surface hydrologic processes on Earth's climate?
  - How do ecosystems respond to and affect global environmental change and the carbon cycle?
  - How can climate variations induce changes in the global ocean circulation?
  - How do stratospheric trace constituents respond to change in climate and atmospheric composition?
  - How is global sea level affected by climate change?
  - What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?

- ***What are the consequences of change in the Earth-Climate system for human civilization? (Consequences-C)***
  - How are variations in local weather, precipitation and water resources related to global climate variation?
  - What are the consequences of the interaction between climate and land cover and land use change in regard to the sustainability of ecosystems and economic productivity?
  - What are the consequences of climate and sea level changes and increased human activities on coastal regions?

- ***How well can we predict future changes to the Earth-Climate system? (Prediction-P)***
  - How well can weather forecast duration and reliability be improved by new in-situ and space-based observations, data assimilation, and modeling?
  - How well can transient climate variations be understood and predicted?
  - How well can long-term climatic trends be assessed or predicted?
  - How well can future atmospheric chemical impacts on ozone and climate be predicted?

The U.S.-GCOS effort is designed to aid in addressing these scientific questions, and contributes to all the international programs mentioned and their respective objectives. Following the UNFCCC reporting guidelines, adopted by COP-5, the U.S. contribution to GCOS regarding both in-situ and space-based observations are described in this report. Both operational and research systems are included in accord with the GCOS coordinators' guidance, elaborating on the UNFCCC guidelines.

ACRONYMS

AAO	Adjacent Arctic Ocean
ACARS	Aircraft Communications, Addressing, and Reporting System
ACORN	Atmospheric Coordinated Observations and Research Network
ACRIM	Active Cavity Radiometer Irradiance Monitor
AIRMoN	Atmospheric Integrated Research Monitoring Network
AIRS	Atmospheric Infrared Sounder
AMSU	Advanced Microwave Sounding Unit
AO	Arctic Oscillation
ARCS	Atmospheric Radiation and Cloud Stations
ARL	Air Resources Laboratory
ARM	Atmospheric Radiation Measurement
ART	Automated Radiotheodolite
ASAP	Automated Shipboard Aerological Program
ASDAR	Aircraft-to-Satellite Data Relay
ASMR	Advanced Scanning Microwave Radiometer
ASOS	Automated Surface Observing System
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATLAS	Autonomous Temperature Line Acquisition System
ATMS	Advanced Technology Microwave Sounder
ATN	Advanced TIROS-N
AWOS	Automated Weather Observing System
AVHRR	Advanced Very High Resolution Radiometer
BATS	Bermuda Atlantic Time Series
BLM	Bureau of Land Management
BR	Bureau of Reclamation
BSRN	Baseline Surface Radiation Network
BTM	Bermuda Testbed Mooring
C-MAN	Coastal-Marine Automated Network
CALM	Circumpolar Active Layer Monitoring
CART	Cloud and Radiation Testbed
CDC	Climate Diagnostics Center

CDIAC	Carbon Dioxide Information Analysis Center
CDR	Climate Data Record
CERES	Clouds and the Earth's Radiant Energy System
CEOS	Committee on Earth Observation Satellites
CES	Committee on Earth Studies
CFC	Chlorofluorocarbon
CGMS	Coordination Group for Meteorological Satellites
CHAMP	Coral Health and Monitoring Program
CLAES	Cryogenic Limb Array Etalon Spectrometer
CLIVAR	Climate Variability and Predictability Proramme
CMDL	Climate Monitoring and Diagnostic Laboratory
CMIS	Conical Microwave Imager/Sounder
CNES	Centre National de'Etudes Spatiales
CO_2	Carbon Dioxide
CO-OPS	Center for Oceanographic Products and Services Division
COOP	Cooperative Observing Network
COP	Conference of the Parties
COSMIC	Constellation Observing System for Meteorology, Ionosphere and Climate
CREWS	Coral Reef Early Warning System
CrIS	Cross-track Infrared Sounder
CRN	Climate Reference Network
CZCS	Coastal Zone Color Scanner
DAC	Data Acquisition Center
DAAC	Distributed Active Archive Center
DMS	Data Management System
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOD	Department of Defense
DODS	Distributed Oceanographic Data System
DOE	Department of Energy
DOI	Department of the Interior
EDC	EROS Data Center

EDR	Environmental Data Record
EEZ	Exclusive Economic Zone
EOS	Earth Observing Satellite
EOSDIS	Earth Observing Satellite Data and Information Systems
EPA	Environmental Protection Agency
EPIC	Eastern Pacific Investigation of Climate Processes
ERBE	Earth Radiation Budget Experiment
EROS	Earth Resources Observations Systems
ETM	Enhanced Thematic Mapper
EUMETSAT	European Meteorological Satellite Organization
EWG	Environmental Working Group
FAA	Federal Aviation Administration
FAO	Food and Agriculture Organization
FIA	Fire Inventory and Analysis
FWS	Fish and Wildlife Service
G^3OS	Three Global Observing Systems (GCOS, GOOS, and GTOS)
GAW	Global Atmosphere Watch
GCM	General (or Global) Circulation Model
GCMD	Global Change Master Directory
GCDIS	Global Change Data and Information System
GCOS	Global Climate Observing System
GCRMN	Global Coral Reef Monitoring Network
GDP	Global Drifter Program
GHCN	Global Historical Climatological Network
GLOSS	Global Sea Level Observing System
GMS	Geostationary Meteorological Satellite (Japanese)
GOES	Geostationary Operational Environmental Satellite
GOME	Global Ozone Monitoring Experiment
GOOS	Global Ocean Observing System
GOSIC	Global Observing System Information Center
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning Satellite

GPSOS	GPS Occultation
GRACE	Gravity Recovery and Climate Experiment
GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network for Glaciers
GTN-P	Global Terrestrial Network for Permafrost
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunications System
GUAN	GCOS Upper Air Network
HALOE	Halogen Occultation Experiment
HCDN	Hydro-Climatic Data Network
HIRDLS	High Resolution Dynamic Limb Sounder
HIRS	High Resolution Infrared Sensor
HRDI	High Resolution Doppler Imager
HOTS	Hawaii Ocean Time Series
HSB	Humidity Sounder for Brazil
IABP	International Arctic Buoy Program
ICES	Ice Cloud and Land Elevation Satellite
IGBP	International Geosphere-Biosphere Program
IGBP-DIS	International Geosphere-Biosphere Program Data and Information System
IGFA	International Group of Funding Agencies for Global Change Research
IGOS	International Global Observing Strategy
IGOSS	Integrated Global Ocean Services System
IMET	Improved Meteorological instruments
IMPROVE	Interagency Monitoring of Protected Visual Environments Network
IOC	International Oceanographic Commission
IORD	Integrated Operational Requirements Document
IPA	International Permafrost Association
IPCC	Intergovernmental Panel on Climate Change
IPO	Integrated Program Office
IPSLN	Indo-Pacific Sea Level Network
IPW	Integrated Precipitable Water
ISAMS	Improved Stratospheric and Mesopheric Sounder

ISCCP	International Satellite Cloud Climatology Project
ISIS	Integrated Surface Irradiance Study
ISLP-Pac	IGOSS Sea Level Project in the Pacific
JASL	Joint Archive for Sea Level
JDIMP	Joint Data and Information Management Panel
JGOFS	Joint Global Ocean Flux Study
LCCP	Land Cover Characterization Program
LCTP	Land Cover Trends Project
LDCM	Landsat Data Continuity Mission
LEO	Low Earth Orbit
LIAG	Lake Ice Analysis Group
LTAP	Long Term Acquisition Plan
LTER	Long Term Ecological Research
MACS	Monitoring and Control System
MAP3S	Multistate Atmospheric Power Production Pollution Study
MBLA	Multi-Beam Laser Altimeter
METOP	Mid-morning Orbital Plane Satellite
MISR	Multi-angle Imaging Spectrometer
MLS	Microwave Limb Sounder
MISR	Multi-angle Imaging SpectroRadiometer
MITI	Japan's Ministry of International Trade and Industry
MMTS	Maximum-Minimum Temperature Systems
MODIS	Moderate Resolution Imaging Spectroradiometer
MON	Marine Observational Network
MOPITT	Measurement of Pollution in the Troposphere
MRLC	Multi-Resolution Land Characterization
MSS	Multi-Spectral Scanner
MSU	Microwave Sounding Unit
NADP	National Atmospheric Deposition Program
NAO	North Atlantic Oscillation
NASA	National Aeronautics and Space Administration
NAVAID	Navigational Aid

NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NDBC	National Data Buoy Center
NDBO	NOAA Data Buoy Office
NDSC	Network for the Detection of Stratospheric Change
NDVI	Normalized Difference Vegetation Index
NEON	National Ecological Observation Network
NEP	Net Ecosystem Production
NESDIS	National Environmental Satellite, Data, and Information Service
NEXRAD	Next Generation Weather Radar
NGWLMS	Next Generation Water Level Measurement System
NIST	National Institute of Standards and Technology
NLCD	National Land Cover Dataset
NMS	National Meteorological Services
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NOHRSC	National Operational Hydrologic Remote Sensing Center
NOMAD	Naval Oceanographic and Meteorological Automated Device
NOPP	National Oceanographic Partnership Program
NORLC	National Ocean Research Leadership Council
NOS	National Ocean Service
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSA	North Slope of Alaska
NSCAT	NASA Scatterometer
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
NSIP	National Streamflow Information Program
NTN	National Trends Network

NWCC	National Water and Climate Center
NWLON	National Water Level Observation Network
NWP	Numerical Weather Processing
NWS	National Weather Service
OAR	Oceanic and Atmospheric Research
OFCM	Office of the Federal Coordinator for Meteorology
OGP	Office of Global Programs
OLS	Operational Linescan System
OMPS	Ozone Mapping and Profiler Suite
OOSDP	Ocean Observing System Development Panel
QME	Quality Measurement Experiment
PEM	Particle Environment Monitor
PI	Principal Investigator
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
POES	Polar Orbiting Environmental Satellite
RASS	Radio-Acoustic Sounding System
RAWS	Remote Automated Weather Stations
RCC	Regional Climate Centers
RH	Relative Humidity
S_2O_2	Sargasso Sea Ocean Observatory
SAB	Science Advisory Board
SAGE	Stratospheric Aerosol and Gas Experiment
SBUV	Solar Backscatter Ultraviolet
SC	State Climatologist
SCAN	Soil Climate Analysis Network
SDD	Space Data Division
SEAS	Shipboard Environmental (data) Acquisition System
SeaWiFS	Sea-viewing Wide-Field-of-view Sensor
SEM	Space Environment Monitor
SESS	Space Environment Sensor Suite
SGP	Southern Great Plains
SHEBA	Surface Heat Budget of the Arctic

SLP	Sea-Level Pressure
SMM	Solar Maximum Mission
SMMR	Scanning Multichannel Microwave Radiometer
SNODAS	Snow Data Assimilation System
SNOTEL	Snowpack Telemetry System
SOC	Specialized Oceanographic Centre
SOEST	School of Ocean and Earth Science and Technology
SOLSTICE	Solar/Stellar Irradiance Comparison Experiment
SOOP	Ships of Opportunity
SORCE	Solar Radiation and Climate Experiment
SR	Scanning Radiometer
SRTM	Shuttle Radar Topography Mission
SSM/I	Special Sensor Microwave/Imager
SST	Sea Surface Temperature
SSU	Stratospheric Sounding Unit
SURFRAD	Surface Radiation Network
SUSIM	Solar Ultraviolet Spectral Irradiance Monitor
SWIR	Shortwave-Infrared
SXI	Solar X-Ray Imager
TAO	Tropical Atmosphere Ocean
TBB	Triband Beacon Transmitters
TES	Tropospheric Emission Spectrometer
TIP	Tiny Ionospheric Photometer
TIR	Thermal-Infrared
TIROS	Television Infrared Observations Satellite
TIROS-N	Next Generation TIROS
TM	Thematic Mapper
TOGA	Tropical Ocean Global Atmosphere
TOMS	Total Ozone Mapping Spectrometer
TOVS	Tiros Operational Vehicle Sounder
TRITON	Triangle Trans Ocean Buoy Network
TRMM	Tropical Rainfall Measuring Mission

TSI	Total Solar Irradiance
TSLC	TOGA Sea Level Center
TSG	ThermoSalinoGraph
TSIS	Total Solar Irradiance Sensor
TWP	Tropical Western Pacific
UARS	Upper Atmosphere Research Satellite
UHSLC	University of Hawaii Sea Level Center
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USCOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGCRP	United States Global Change Research Program
USGS	United States Geological Survey
USHCN	United States Historical Climatology Network
UTC	Universal Coordinated Time
VCL	Vegetation Canopy Lidar
UV	Ultraviolet
VAP	Value Added Procedure
VIIRS	Visible Infrared Imager Radiometer Suite
VNIR	Visible and Near-Infrared
VOS	Voluntary Observing Ship
WCRP	World Climate Research Program
WFO	Weather Forecast Office
WIMS	Weather Information Management System
WMO	World Meteorological Organization
WOA	World Ocean Atlas
WOCE	World Ocean Circulation Experiment
WSR-88D	Weather Surveillance Radar - Doppler
WWW	World Wide Web
XBT	eXpendable Bathy Thermograph